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# AGRICULTURAL NEWS LETTER

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This publication contains information regarding new developments of interest to agriculture based on laboratory and field investigations of the du Pont Company and its subsidiary companies. It also contains published reports and direct contributions of investigators of agricultural experiment stations and other institutions as related to the Company's products and other subjects of agricultural interest.



AGRICULTURAL NEWS LETTER

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CONTENTS

	<u>Page</u>
"Self-Cleaning" Paints.....	63
Composition of Ammoniated Superphosphate.....	64
Panama Canal Zone Test House Repels Termites.....	68
Methyl Bromide as a Mill Fumigant.....	69
Treatment of Tobacco Plant Bed Soil with Nitrogenous Fertilizers.....	72
Research Laboratories receive A-2 Priority Rating.....	79

### "SELF-CLEANING" PAINTS

EDITOR'S NOTE: Many white paints collect and hold dirt and dust from the atmosphere. This results in premature graying. Now, from research, comes a prepared house paint having the ability to clean itself. The "self-cleaning" characteristic - available in tints as well as in white - is described below and in a booklet, "Let's Talk About Painting Your House," which may be obtained from the Fabrics & Finishes Department of E. I. du Pont de Nemours & Company, Inc.

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Research in paint and pigment technology has resulted in the development by Du Pont chemists of improved house paints which clean themselves under the action of rain, wind and sun.

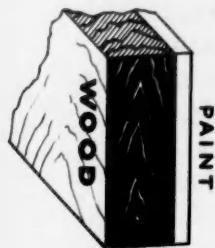
As these paints age, they accumulate a fine powder on the surface. Heavy rains wash it away. Under normal conditions, dirt which settles on the surface is also washed away with the powder, exposing a fresh, clean surface.

The "self-cleaning" process begins after the paint starts to powder or chalk. This happens in a few months under ideal conditions of climate and exposure, but may be delayed for a longer period under unusual climatic conditions. "Self-cleaning" - made possible by Du Pont's use of titanium dioxide pigments - is continuous, thus keeping exterior surfaces cleaner and brighter than has heretofore been possible.

The cleaning process is gradual, however, and does not adversely affect the wearing qualities of the film. Years of weathering leave the surface in excellent condition for repainting.

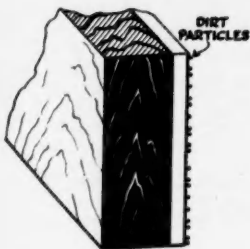
For years, Du Pont has maintained "test farms" in Concordville, and Philadelphia, Pa.; Hialeah, Florida; Amarillo, Texas; Parlin, N. J.; Flint, Michigan; Chicago, Illinois; Louviers, Colorado, and San Francisco, California. Approximately 60,000 panels coated with various types of paints are subject to more than a million inspections annually and a record is kept of how the paint surfaces stand up under attacks of hot sun, rain, sleet, snow, wind-driven dust, corrosive salt air, industrial fumes and smoke. Paints giving promise of good durability are also exposed on hundreds of houses, garages and other buildings. In some instances half of a structure is painted with the new formula paints, while the other portion receives comparable coats of the older-type finishes. Recent comparisons are markedly in favor of the "self-cleaning" paints.

# HOW DU PONT PAINT *Cleans Itself*

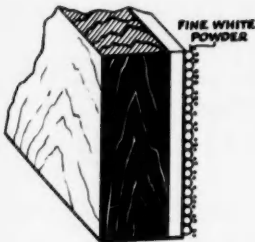


## DUPONT "SELF-CLEANING" WHITE HOUSE PAINT

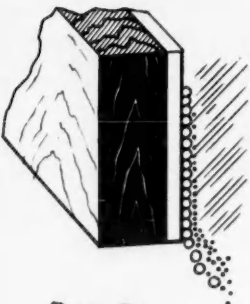
Here is a cross-section drawing which shows microscopically how a coat of Du Pont White House Paint looks when first applied.



Like all paints, this house paint retains some of the dust and dirt from the atmosphere for the first few months.



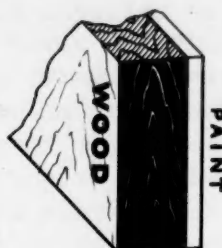
Unlike old-style paints, a fine white powder starts to form on the surface of this paint film after a few months.



Heavy rains carry away this fine white powder and with it much of the accumulated dust and dirt.

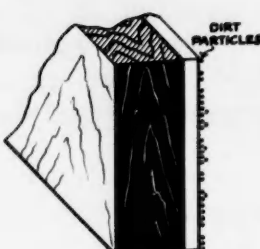


These heavy rains leave the surface clean and white again. As this self-cleaning process continues, it keeps your house whiter than was ever before thought possible.

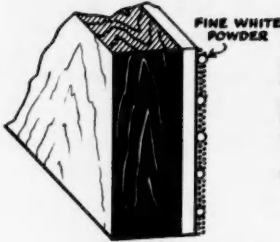


## ORDINARY HOUSE PAINT

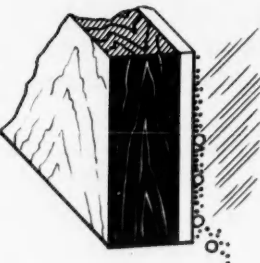
Here is a close-up drawing of a coat of ordinary house paint when first applied.



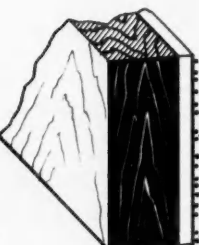
Dirt and dust settle on the surface and much of it becomes firmly embedded.



"Chalk" formation is greatly retarded. With some paints this "powdering" only tends to catch and hold more dirt particles.



Rains wash away only the loose top particles of dirt, leaving much of the dirt and grime behind.



Much of the dust and dirt is so firmly embedded that it doesn't wash off. This makes houses look prematurely gray and dirty, a common failure of many orthodox and "old-fashioned" paints.



### COMPOSITION OF AMMONIATED SUPERPHOSPHATE

EDITOR'S NOTE: As recently as 1925, not a single pound of liquid ammonia was used in fertilizer manufactured in the United States. However, as a result of the practical application of the findings of research, more than one-fourth of the nitrogen now used in mixed fertilizers in this country is supplied by ammonia liquors. Since this development has brought about important changes in fertilizer formulation practice, the following article is of more than ordinary interest. Because it is the first brief but relatively complete discussion of the ammoniation of superphosphate (fertilizer text books having for the most part been written some years ago), reprints of this article will be sent to teachers of agriculture in high schools and universities in sufficient quantities for class room use, upon request.

By-J. B. S. Holmes,  
Ammonia Department,  
E. I. du Pont de Nemours & Co., Inc.,  
Wilmington, Delaware.

#### Ammoniation of Superphosphate Fertilizers:

For more than ten years the fertilizer industry has taken advantage of the fact that superphosphate will absorb liquid ammonia, fixing the nitrogen during the process in a useful form of high crop-producing value. Anhydrous ammonia, available in large quantities and at low cost as a result of the United States' new synthetic nitrogen industry, was first utilized for the ammoniation of superphosphate. This has been displaced by newer ammoniating solutions specifically designed for the fertilizer industry, which make possible the incorporation of larger quantities of nitrogen in the superphosphate than could be obtained from anhydrous ammonia.

At Belle, West Virginia, the Du Pont Company produces Urea-Ammonia Liquors for the fertilizer industry. These consist of urea dissolved in an ammonia-water system, thereby furnishing a mixture of "free ammonia", which reacts with the superphosphate, and "fixed nitrogen" (urea) which is precipitated in the fertilizer mixture as fine crystals that are non-reactive. UAL-B, the liquor most extensively used, contains 45.5% total nitrogen of which 20.5% nitrogen is present as urea and 25% as free ammonia.

The liquor is shipped in tank cars to the fertilizer plant and forced by means of air pressure through suitable piping to a small measuring tank in which the desired charge is measured. It is then led directly into the fertilizer mixer through a spray pipe which insures intimate contact and practically instantaneous absorption by the superphosphate.

#### Changes in Fertilizer Practice:

In addition to providing low-cost, easily-handled nitrogen, ammoniating solutions produce dry, free-flowing fertilizers which cure more rapidly and tend to be less dusty than when made by the older method. The liquid forms of nitrogen, therefore, have found wide acceptance. It is estimated that 80% of the fertilizer plants manufacturing 5,000 tons or more of fertilizer annually, employ ammonia liquors.

It is interesting to note the effect that ammoniating liquors have had in changing fertilizer formulation practice. Approximately 60,000 tons of nitrogen in the form of liquors of all kinds were supplied to fertilizer manufacturers in the 1939-1940 season. These have naturally displaced other materials. The extent of this change is shown in Table I.

TABLE I

The Use of Various Forms of Nitrogen in Mixed Fertilizers in 1925 and 1940  
(Continental U.S.A.)

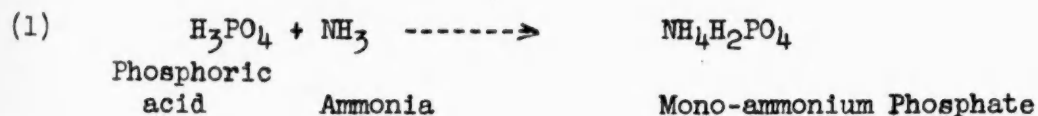
	Per Cent of Total in		
	1925	:	1940
Ammonium Sulphate	38.1	:	38.7
Nitrates	21.9	:	11.4
Synthetic Organics	11.9	:	11.0
Natural Organics	31.0	:	12.1
Ammonia Liquors (1)	-	:	26.8

(1) Includes dissolved urea and nitrates.

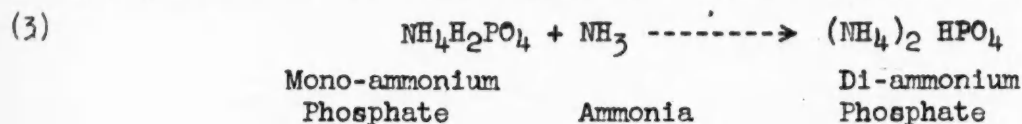
Data for 1925 are given by Mehring and Peterson<sup>(1)</sup>. Figures for 1940 are from the best estimates available. It is evident that during this fifteen-year period, ammoniating liquors have developed into a major source of fertilizer nitrogen, second only to ammonium sulphate. The use of natural organic materials and nitrates in mixed fertilizers has decreased during the same period. "Uramon" Fertilizer Compound, a du Pont product first produced in 1937, accounts for a substantial percentage of the synthetic organic nitrogen in 1940.

#### Chemistry of Superphosphate Ammoniation:

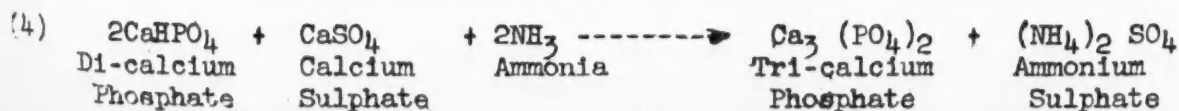
When UAL-B is added to a superphosphate, the free ammonia in the liquor reacts with the free phosphoric acid, forming mono-ammonium phosphate. Additional quantities of ammonia convert mono-calcium phosphate to mono-ammonium phosphate and di-calcium phosphate. These reactions are shown in equations (1) and (2):



When reaction (2) is completed, further additions of ammonia react with mono-ammonium phosphate to form di-ammonium phosphate, as in equation (3):



Under commercial operating conditions, where temperatures are kept low and storage time is short, at least some of the di-ammonium phosphate is stable. However, at high temperatures and in the presence of moisture, di-ammonium phosphate will decompose, liberating ammonia. This in turn, will react with di-calcium phosphate and gypsum, forming ammonium sulphate and precipitated tri-calcium phosphate:



This precipitated tri-calcium phosphate, probably because it contains no fluorides, is considerably more available to plants, as determined by vegetative experiments, than raw rock phosphate. "Available" phosphoric acid, as determined by official analysis methods, consists of water-soluble phosphates and those compounds dissolved by a definite quantity of neutral ammonium citrate solution. The latter includes all the di-calcium phosphate and about 20 pounds  $P_2O_5$  as precipitated tri-calcium phosphate, in addition to small quantities of other phosphates, such as magnesium ammonium phosphate. The portion of tri-calcium phosphate in excess of 20 pounds  $P_2O_5$  is insoluble and usually referred to as "reverted" phosphate. There is some evidence to indicate that basic tri-calcium phosphates and apatite may be formed under certain conditions; these are insoluble in the citrate solution.

#### Composition of Ammoniated Superphosphate:

Figure I shows the effect of progressive ammoniation on the composition of a typical superphosphate. The reactions already discussed may be followed on this figure. The addition of about 2% nitrogen as free ammonia completes reaction (1) and (2). Further additions of free ammonia initiate reactions (3) and (4).

Figure I is based on results of research work on phosphate reactions conducted by Keenen (2). In order to insure completion of all reactions, Keenen purposely maintained abnormally high moistures and temperature. The formation of precipitated tri-calcium phosphate and ammonium sulphate, as indicated in this figure, is somewhat higher than would be encountered in commercial practice.

Figure II, prepared from the same data, illustrates the distribution of phosphates in fertilizers containing 8% available phosphoric acid. That shown in Chart A is ammoniated at the rate of 66 pounds UAL-B per ton, furnishing a total of 1.5% nitrogen. This rate would represent the minimum used in commercial practice. Approximately 57% of the phosphoric acid is water soluble and therefore subject to rather rapid "fixation" in the soil. The balance is citrate soluble and therefore less subject to "fixation".

Chart B indicates the effect of increasing the amount of UAL-B to 85 pounds per ton, supplying 1.94% nitrogen, and representative of the average commercial practice. The phosphoric acid is now derived from three sources of differing solubilities. Water-soluble mono-ammonium phosphate, capable of rapid "fixation", comprises 53.5% of the total. More slowly "fixed" citrate soluble di-calcium phosphate accounts for 35.5%, and 11% citrate-soluble tri-calcium phosphate has been formed. This compound is even less subject to soil "fixation".

It is evident, therefore, that ammoniation converts superphosphate, composed very largely of water-soluble, easily "fixed" mono-calcium phosphate, into "available" phosphate compounds of varied solubility, some of which are less susceptible to soil "fixation".

For easy reference to Figure I, the ammoniation rates used in Charts A and B, when converted to the basis of a ton of superphosphate, are equivalent to 2% nitrogen as free ammonia and 2.32% nitrogen as free ammonia, respectively.

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Fig. 1.

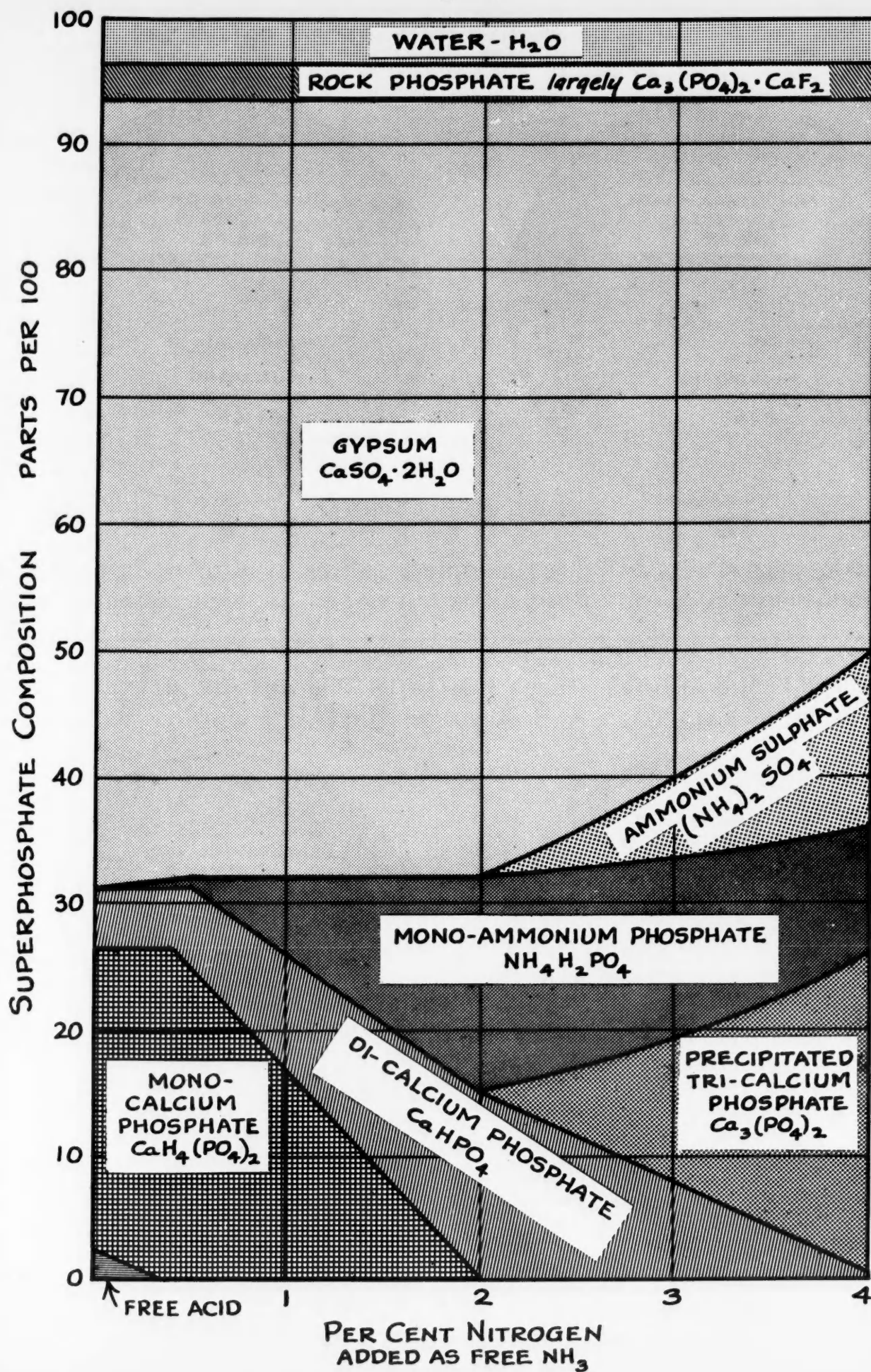
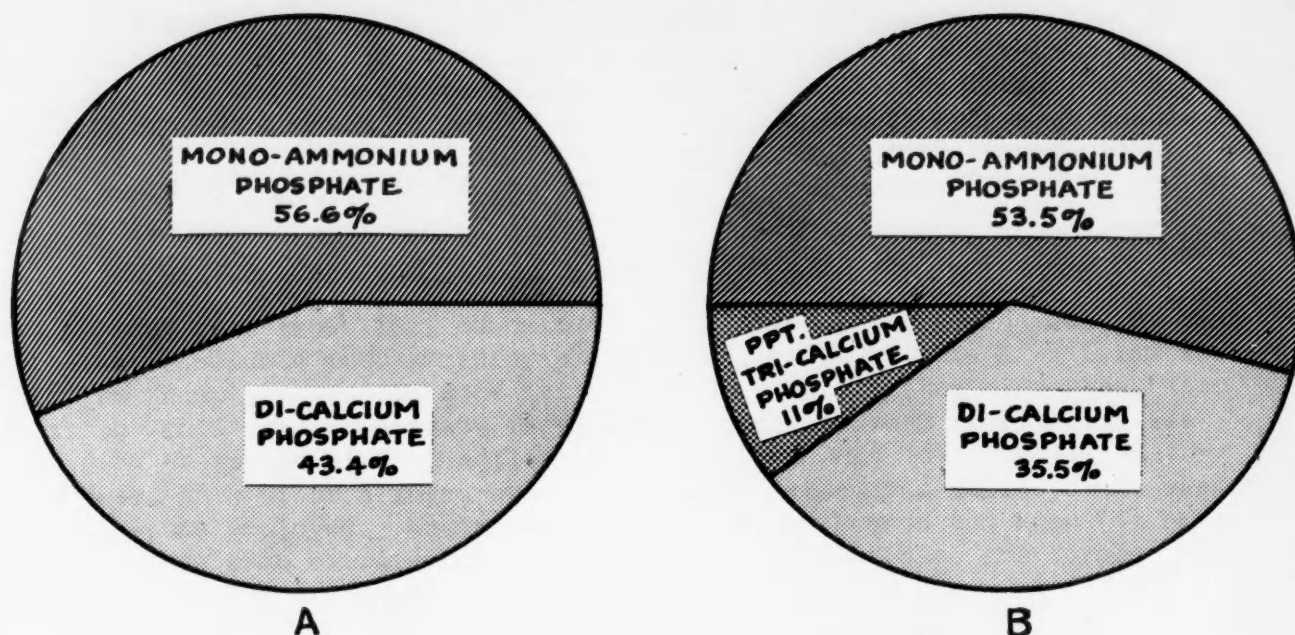


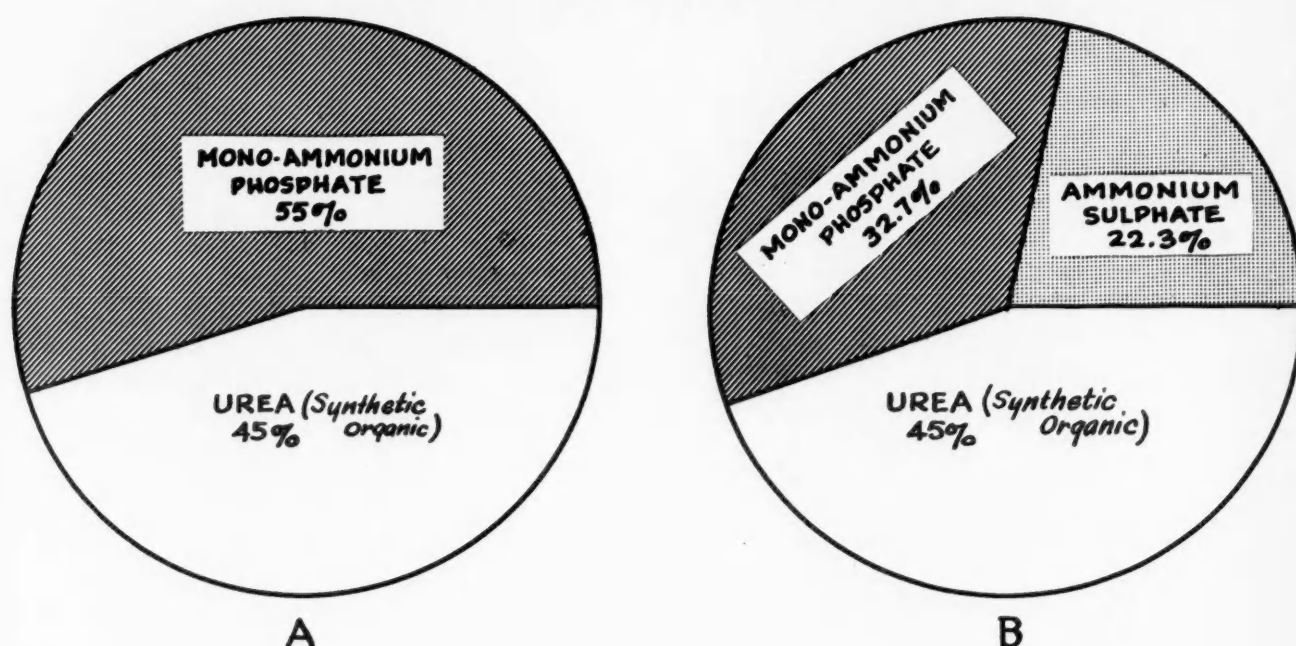


FIG. II THE DISTRIBUTION OF PHOSPHORIC ACID IN AN X-8-X FERTILIZER



A-Ammoniation rate: 20lbs. free ammonia per 890 lbs. Superphosphate  
 B-Ammoniation rate: 25 lbs. free ammonia per 890 lbs. Superphosphate

FIG. III THE DISTRIBUTION OF NITROGEN SUPPLIED BY UAL-B IN AN X-8-X FERTILIZER



A-Ammoniation rate: 66 lbs. UAL-B per 890 lbs. Superphosphate  
 B-Ammoniation rate: 85 lbs. UAL-B per 890 lbs. Superphosphate

Figure III illustrates the nitrogen distribution in the same manner. At the low ammoniation rate, UAL-B forms two nitrogen compounds, urea and mono-ammonium phosphate. With the higher rate, sulphate of ammonia is also formed. The precipitation of urea and the formation of the nitrogen and phosphate compounds by chemical reaction within the mixture show how the use of Urea-Ammonia Liquor tends to overcome segregation of the fertilizer ingredients.

#### Value of Phosphoric Acid in Ammoniated Superphosphate:

It has already been shown that ammonia converts water soluble mono-calcium phosphate to water soluble mono-ammonium phosphate, citrate soluble di-calcium and tri-calcium phosphate and, in some instances, insoluble tri-calcium phosphates. In order to "cure" superphosphate fertilizers, manufacturers must neutralize mono-calcium phosphate with an active alkali. If ammonia is not utilized for this purpose, some other alkali, such as cyanamid, lime, vegetable potash wastes or limestone, is employed. Keenen and Morgan (3) and Beeson and Ross (4) have shown that these same citrate-soluble and insoluble phosphates are formed, in varying degree, when such neutralizing agents are used.

The high availability of mono-calcium phosphate, mono-ammonium phosphate and di-calcium phosphate is generally recognized. The water-soluble phosphates react with soil components to form relatively insoluble phosphates as soon as they are applied to the soil. The degree of availability depends on a number of factors but it is generally recognized that calcium phosphates, formed in limed soils, are more available than iron and aluminum phosphates, formed in acid soils. There is some evidence to show that on acid soils the less soluble di- and tri-calcium phosphates are more available than water-soluble phosphates. Such differences are explained by differences in rate of fixation by iron and aluminum compounds in the acid soils.

Raw rock phosphate is of questionable value, compared to superphosphate, when applied to the soil direct or as an ingredient of fertilizer. On highly acid soils, rock phosphate may produce increased yields, compared to no phosphate at all. On the other hand, precipitated tri-calcium phosphate, as found in ammoniated fertilizers, is considerably more available. In this respect, it seems to be like bone meal or basic slag, materials of relatively high phosphate value. It is believed that the absence of fluorides accounts for the higher availability of these compounds when compared to rock phosphate. The fine particle size of tri-calcium phosphate, precipitated by chemical reaction within the fertilizer, may also account for better availability.

#### REFERENCES

- (1) A. L. Mehring and A. J. Peterson: USDA Circular No. 315, April 1934.
- (2) Frank G. Keenen: Ind. & Eng. Chem., Vol. 22, Dec. 1930.
- (3) Keenen & Morgan: Ind. & Eng. Chem., Vol. 29, Feb. 1937.
- (4) Beeson & Ross: Ind. Eng. Chem., Vol. 26, 1934.

PANAMA CANAL ZONE TEST HOUSE REPELS TERMITES.

EDITOR'S NOTE: Termites and wood-consuming fungi take an immense toll - but lumber that has been chemically treated is definitely not on their menu. Du Pont specialists say that a home properly protected against rot and termites by the use of lumber pressure-impregnated with chromated zinc chloride is but two per cent more costly.

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A test house built on a Canal Zone island 15 years ago with chemically treated lumber continues to repel termite attack, investigators of the U. S. Bureau of Entomology report in the latest issue of "Wood Preserving News".

Because Barro Colorado Island, Panama, is the most heavily infested termite area in North America, wood untreated with preservatives is devoured within a year.

In 1926, the American Wood Preservers' Association supplied yellow southern pine impregnated with zinc chloride to the Bureau of Entomology. Also furnished for the construction of the test house was a quantity of creosoted timber supports.

Since that time the building has been inspected at varying intervals. Although termites soon built so-called "shelter tubes" along supports reaching in some cases to the roof, it was stated that in no instance had they entered the treated wood. The shelter tubes leading from the underground homes of the pests - responsible for many millions of dollars worth of damage annually - were eventually abandoned.

"Bait stakes" of untreated wood placed inside the house were entirely consumed by termites.

Although the moist, hot tropical climate of the Canal Zone is conducive to rapid wood rot, the Bureau reported its inspection of the test house shows the chemically treated timbers to be in perfect condition on this score as well.

METHYL BROMIDE AS A MILL FUMIGANT

EDITOR'S NOTE: This is the second article on methyl bromide as a fumigant published in the Agricultural News Letter. Vol. 9, No. 4 (July-August, 1941) carried a general statement on its advantages and gave recommendations for its use. The following discussion of its use for a specific purpose -- as a fumigant for grain mills -- is based on research conducted by the U.S. Bureau of Entomology and Plant Quarantine, which found that proper doses gave satisfactory kills in modern, tight, concrete or brick mills. The results of these experiments led the Bureau to conclude that methyl bromide has a definite place in the field of mill fumigants.

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Methyl bromide is comparatively new as a flour-mill fumigant, although it has been recognized since 1935 as a fumigant for treating living plants and plant products. Recently R. T. Cotton, George B. Wagner and T. F. Winburn of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, were prompted by the interest of millers to make an extensive investigation into the possible use of methyl bromide in the control of pests in grain mills.

The results of the tests are reported in the January 1941 issue of the "American Miller." As a result of this work they concluded that methyl bromide has a definite field as a mill fumigant. Further work, however, will be carried out to determine the limits in this field. As pointed out in the general article in the July-August Agriculture News Letter methyl bromide offers advantages for some applications. However, like other fumigants, methyl bromide has its limitations.

Methyl bromide is relatively cheap, highly toxic to insects, non-inflammable, quite stable chemically, has low water solubility, and can be used at comparatively low temperatures. It can be handled with comparative safety by anyone familiar with its properties and experienced in the handling of fumigants, but extreme care must be taken in its use because it lacks a distinctive odor at concentrations toxic to man.

The Cotton-Wagner-Winburn report states: "In the fumigation of modern, tight, concrete mills, satisfactory kills have been obtained with methyl bromide at a dosage of 1 lb. per 1,000 cu. ft. of space. In a number of flour-mill fumigations in which attempts were made to study the reaction of the gas under all possible conditions, it was found that the best results were obtained when accumulations of milling stock were left in the machinery." However, inasmuch as methyl bromide is slower acting than other fumigants such as HCN gas it is not recommended for use in a building loosely constructed, because leakage prevents maintenance of a lethal concentration for sufficient time to be effective.

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Generally speaking, unless a mill is of modern brick or concrete construction, the use of hydrocyanic acid gas, with which millers have long been familiar, is recommended.

Careful preparation of a mill for methyl bromide fumigation will be rewarded with a better kill. The procedure is similar to that for hydrocyanic acid gas fumigation. Cotton and his collaborators suggest that the following be observed:

"The entire building should be closed as tightly as possible; all windows should be tightly wedged and sealed and any broken panes replaced; loosely fitting window sashes should be sealed with paste and paper, or 'puttied up' with a mixture of flour and oil; doors should be sealed in a similar manner. In addition:

1. Open all machines, conveyor boxes and flour bins, and all repair openings to spouts, elevator legs, etc., and wedge open all feeder gates on rolls and purifiers.
2. Remove covers of all conveyors, making certain that all dead-end spaces are readily accessible.
3. Open dust collectors, back drafts, main trunks, and air-inlet regulators.
4. Remove all sifter doors to permit entrance of gas during fumigation; remove sieves and stack them on the floor.
5. Seal ventilators and replace mushroom-shaped caps with a tight metal cap.
6. Do not remove accumulations of stock from elevator boots or milling units.

"As far as practical, each floor should be treated as a separate unit, doors between floors, to stair-wells and freight elevators being closed, although some interchange of gases will necessarily take place through the slide spouts and elevator legs."

The amount of methyl bromide needed can be calculated on the basis of one pound per 1000 cubic feet to be fumigated. A dosage chart should be prepared showing the amount of methyl bromide that should be applied to each floor on this basis. Each floor should thus be considered as a unit, but if this is not practical, slightly more gas should be applied to the upper floors, since the gas is heavier than air.

Methyl bromide may be applied through the same type of piping system used for the application of liquid hydrocyanic acid by the open-space method. The 150-pound cylinder will usually be found economical for fumigation of large mills.

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Each cylinder of methyl bromide is equipped with a siphon tube so that it can be emptied without inverting the cylinder. A flow rate of about ten pounds per minute into the lines may be maintained by boosting the air pressure in the cylinder to 150 pounds before connecting it to the piping system. In cold weather it is sometimes necessary to increase the pressure a second time to assure rapid flow. A 16- to 25-hour exposure to the gas should be allowed, after which the building may be opened up for aeration. Gas masks should be worn in opening up the mill.

Since methyl bromide is absorbed and retained by the milling stock, it is well to set aside the first 12 barrels produced per each 500-barrel capacity after milling is resumed. Later this flour can be fed back into the mill.

At ordinary temperatures and pressures methyl bromide is a colorless gas with slight chloroform odor, about  $3\frac{1}{2}$  times heavier than air. For convenience, however, it is supplied as a liquid under pressure, either in 50- and 150-pound siphon-type cylinders or in cases containing 24 one-pound cans. The liquid is easily removed from containers and readily volatilizes to the gas at atmospheric pressure and temperatures above 40°F.

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TREATMENT OF TOBACCO PLANT BED SOIL WITH NITROGENOUS FERTILIZERS

EDITOR'S NOTE: The need for a dependable and practical method for treating tobacco plant-bed soil to destroy weed seeds and certain parasitic organisms has become more urgent in recent years. Steam sterilization of plant-bed soil is effective but too expensive, and few farmers have the necessary equipment. Prof. R. G. Henderson therefore undertook a study of the use of nitrogen fertilizers, the results of which we are glad to report in some detail in the following paper. Professor Henderson, as his report shows, found that heavy applications of materials that undergo rapid ammonification in the soil, such as urea, gave very promising results.

By - R. G. Henderson,  
Associate Plant Pathologist,  
Virginia Agricultural Experiment Station,  
Blacksburg, Va.

Suitable sites for plant beds on virgin soil which is relatively free of weed seeds are becoming scarcer each year. The universal presence of tobacco downy mildew necessitates the planting of more plant beds and having them conveniently located so that control measures for downy mildew can be applied. It is quite essential that some method of soil sterilization be applied to plant beds located in open fields, in gardens, or on old plant bed sites. The control of weeds in such locations is always a difficult problem and the disease hazard caused by soil-borne organisms is also greatly increased. Steam sterilization of plant-bed soil is effective but too expensive, and furthermore only a very few farmers have the necessary equipment for making this treatment.

A study of the use of chemicals for sterilizing soil was begun in 1936, and a progress report made on the preliminary results in 1938 (2). Several of the materials tested were found to be partially effective in destroying weed seeds, while others had little or no value. Heavy applications of materials such as urea, calcium cyanamid and cottonseed meal, that undergo rapid ammonification in the soil were found to give very promising results.

In the preliminary tests, treatments were made only one to two weeks prior to the time of seeding the bed. It was observed, however, that this did not allow sufficient time for complete ammonification of the large amount of material applied to the soil. Furthermore, since the plant beds had been prepared and seeded to tobacco in February, the soil temperature was rather low when treatments were made and for that reason ammonification was naturally slower than if the soil temperature had been higher. In later experiments the treatments

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were made in early fall before the soil temperature dropped. Treatments made at this time had the advantage of higher soil temperature and also had sufficient time for the ammonia liberated to be dispersed or tied up by soil organisms before the tobacco was seeded in February. For example, the field test conducted at Chatham, Virginia, during the 1940-41 season was carried out as follows: The plot of ground set aside for the test was plowed about September 1. On October 1, the seed bed was prepared and the frame for the plant bed was put in place, after which the desired amount of material to be used was weighed out and thoroughly mixed with the soil to a depth of 4 or 5 inches. In this particular test urea and calcium cyanamid were used on separate plots at the rate of 1 pound per square yard of plant bed space. The plant bed was then covered with straw to a depth of 8 to 12 inches so as to conserve moisture and protect the treated soil against wind blown weed seed. On February 6, 1941, the straw was carefully removed and fertilizer scratched into the top layer of soil with a garden rake. The plots which had previously been treated with either urea or calcium cyanamid received an 0-8-3 fertilizer at the rate of 2 pounds per square yard, whereas the untreated check plots received a 4-8-3 mixed fertilizer at the same rate. The following week all plots were seeded to tobacco in the usual manner. The stand of tobacco plants obtained on all plots was quite satisfactory. The growth of the seedlings early in the season, although somewhat delayed by cold weather, was normal in other respects. Later, the plants on the urea- and calcium cyanamid-treated plots appeared to be suffering slightly from nitrogen deficiency. To remedy this, if possible, nitrate of soda at the rate of 3 pounds to 100 square yards was applied to these plots on April 30 and again on May 10. At setting time the plants on these plots were strong and vigorous but not too succulent for good transplants. The plants on the untreated plot were choked out by weeds, and the stand of seedlings was greatly reduced during the weeding operation which was required at frequent intervals. The counts on the number of weeds in the treated and untreated plots are given in table 1.

Table 1.—Weed counts on treated and untreated plots at Chatham, Virginia\*

: <u>Number of weeds pulled per square yard on</u> :								
Treatment	:	April 17	:	April 24	:	April 30	:	Total
Urea	:	0	:	0	:	46	:	46
Calcium cyanamid:	:	0	:	0	:	130	:	130
Untreated**	:	828	:	596	:	558	:	1982

\*These figures are taken from a plant bed on which weeds grew during the summer of 1940. Weed counts were also obtained on the area that had been seeded to various grass crops during that period but these data are not given here.

\*\*A large number of weeds appeared in the untreated beds after April 30, but counts after this date were not accurately made. Practically no weeds appeared in the treated beds after April 30.

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The extremely heavy rate of application of urea and calcium cyanamid was expected to cause a great change in the soil flora as well as to alter the reaction of the soil. Hence, the effect of such treatments on the soil reaction, on the concentration of ammonia in the soil and, to a limited extent, on the soil flora has been studied. A Clarksville silt loam soil, at Blacksburg, Virginia, was treated with urea and calcium cyanamid on September 17, 1940. The rate of application for each material was 0.33 pound of nitrogen per square yard. Soil samples were taken at certain intervals for the determination of ammonia, nitrate and pH. The results are given in table 2.

Table 2.—Analyses of soil samples taken from treated and untreated plots at Blacksburg, Virginia. Treatments were made September 17, 1940, at the rate of 0.33 pound nitrogen per square yard

Date	Treatment	pH	Mgm. N per 100 grams dry soil as:	
			NH <sub>3</sub>	NO <sub>3</sub>
Sept. 19	Urea	8.70		
	CaNCN	8.45		
	Check	5.90		
Sept. 28	Urea	8.85	93	None
	CaNCN	8.80	48	"
	Check	6.15	None	Trace
Oct. 14	Urea	8.80	66	None
	CaNCN	8.30	39	"
	Check	6.50	None	Trace
Oct. 24	Urea	8.60	66	None
	CaNCN	8.65	35	"
	Check	6.40	None	Trace
Nov. 4	Urea	8.35	61	1.0
	CaNCN	8.40	37	None
	Check	6.00	None	Trace
Nov. 20	Urea	8.30	60	Trace
	CaNCN	8.50	36	None
	Check	6.00	None	Trace
April 11	Urea	6.00	25	1.2
	CaNCN	8.52	32	Sl. trace
	Check	6.20	None	0.6
May 3*	Urea	5.50	5	7.7
	CaNCN	7.20	18	.9
	Check	5.60	14	10.9

\*2 pounds per square yard of 0-8-3 fertilizer applied to treated plots, and 2 pounds 2-8-3 (nitrogen from nitrate of soda) applied to check plot on April 12.

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The reaction of the urea-treated soil rose from pH 5.9 to pH 8.7 in about 48 hours, while that treated with calcium cyanamid rose to pH 8.45. This high pH was retained by the treated soil during the fall months but by April 11 the soil in the urea-treated plot had a reaction of pH 6.0. The reaction of calcium cyanamid-treated soil, however, was pH 8.5 on this date.

The concentration of ammonia-nitrogen in the urea-treated soil was almost double that in the calcium cyanamid-treated soil during the fall months. On the eleventh day following the treatment there was 93 mgm. ammonia-nitrogen per 100 grams of dry soil in the urea-treated soil and only 48 mgm. in that treated with calcium cyanamid. On April 11 the amount of ammonia-nitrogen had fallen to 25 mgm. in the urea-treated soil, and to 32 mgm. in that treated with calcium cyanamid.

Nitrate-nitrogen in the soil receiving calcium cyanamid has been very low, or absent, in all the experiments conducted. The data recorded in table 2 on a test conducted at Blacksburg show that nitrate-nitrogen was absent in the calcium cyanamid treated soil during the fall months and even by late spring there was less than 1 mgm. per 100 grams of dry soil. On the other hand, soils treated with urea have been high in nitrate-nitrogen after the initial period of ammonification. In some tests it has run as high as 25 mgm. per 100 grams of dry soil. It may be seen from data presented in table 2 that nitrates were present in the untreated soil seven weeks (Nov.4) after treatment and by late spring (May 3) there was approximately 8 mgm. nitrate-nitrogen per 100 grams dry soil.

Counts on soil organisms were not made on the soil in this test until April 9. At that time soil samples from the treated and untreated plots were plated out on sodium caseinate agar for determining the number of bacteria, and on acidified potato dextrose agar for the determination of fungi. The results are recorded in table 3. It appears from these data that calcium cyanamid stimulates the growth of organisms in the soil, while urea may have a slight depressing effect. In this test, however, counts were made during the period that ammonification was in progress. In another test conducted in the greenhouse on a sandy loam soil, counts were made one month after treatment. At that time there was a decrease in the number of fungi and an increase in the number of bacteria in the soil receiving calcium cyanamid, while in the soil receiving urea there was a marked decrease of both fungi and bacteria.

Table 3.—Plate counts of soil organisms in treated and untreated plots at Blacksburg, Virginia. Treatments were made September 17, 1940, at the rate of 0.33 pound nitrogen per square yard

Treatment	: Date of counts	:Thousands of organisms per gram of soil	
		: Bacteria	: Fungi
Urea	: Apr. 9, 1941	: 5,323	: 62
	: May 3, 1941	: 23,900	: 53
CaNCN	: Apr. 9, 1941	: 42,903	: 58
	: May 3, 1941	: 75,000	: 133
Check	: Apr. 9, 1941	: 5,255	: 100
	: May 3, 1941	: 51,300	: 365

Certain studies have been made in the greenhouse and laboratory to determine the effect of urea applications on the fungus which causes black root rot of tobacco (Thielaviopsis basicola). A soil in the greenhouse which was heavily infested with T. basicola was treated with urea at different rates of application. The initial pH of this soil was 6.9. Three rates of application were used, 1/4, 1/2 and 3/4 pound per square yard. The treatments were made June 24. Soil temperatures were not recorded, but the air temperature was always high during daylight. Daily determinations of pH were made on soil samples from each plot. After the soil reaction had receded somewhat, indicating that ammonification was largely completed, an 0-12-4 fertilizer was applied to all plots, except the check, at the rate of 1 pound per square yard and the check plot received 1 pound of 4-12-4 fertilizer per square yard. Three days later all plots were seeded to tobacco.

Some of the results obtained from this experiment are recorded in table 4. The tobacco seedlings on the plot receiving 3/4 pound of urea per square yard were stunted and growth was abnormal at first but later many of these plants made excellent growth. Ammonification was apparently still incomplete when the seed was sown. The roots of the plants were free of root rot. On the plot treated with 1/2 pound urea per square yard the plants made a vigorous growth and their roots were free of infection by T. basicola. The plants on the plot which received 1/4 pound urea per square yard and on both check plots were stunted and an examination of their roots showed that all plants were severely affected with root rot.

The results of this test indicate that the development of root rot on tobacco seedlings is prevented by a heavy application of urea to the soil. The casual organism in the soil may have been destroyed by the excess ammonia produced by the breakdown of urea or the development of the disease may have been prevented by the temporary soil acidity produced on nitrification of the ammonia. The latter, however, seems not to be the explanation since the pH of the soil on the plot receiving 1/4 pound of urea and in which root rot developed was approximately as low at the end of the experiment as that on the plots receiving a heavier application. The highest pH reached in the plot with the light application of urea was 8.0, while the highest with heavier applications, and where root rot was prevented, was 8.65 or more.

Table 4.- Data on Thielaviopsis basicola-infested soil treated with urea.  
Treatments made June 24; seeded to tobacco July 26

Urea applied : per sq. yard :	Highest : pH	pH : Aug. 30	Root rot on : tobacco seedlings	Plant : growth
3/4 pound	8.98	4.91	none	Injured by excess ammonia
1/2 pound	8.65	4.87	none	Normal
1/4 pound	8.00	4.95	severe	Stunted by root rot
Check* (1)	6.90	6.59	very severe	Ditto
Check (2)	6.41	5.70	very severe	Ditto

\*Check (1) received no fertilizer when urea was applied to other plots, but received 1 pound 4-12-4 mixed fertilizer at time tobacco was seeded; check (2) received 1 pound 4-12-4 at the beginning of the experiment; other plots received 1 pound 0-12-4 when tobacco was seeded.

In order to further test the toxicity of ammonia to T. basicola, a series of laboratory experiments were run where different amounts of ammonia salts were added to nutrient media on which this organism was grown. The media were then adjusted to various reactions between pH 6.0 and pH 9.0. It was quite obvious in these tests that ammonia salts inhibited the growth of T. basicola in alkaline media but had no effect in acid media. A concentration of 310 part per million of ammonia-nitrogen in the medium was sufficient to prevent growth when the reaction was pH 8.8, but a slight growth was obtained when the reaction was only pH 8.4. A concentration of 620 parts per million prevented growth at pH 8.6 and 933 p.p.m. prevented growth at pH 8.1.

The analyses of soil samples from plant beds treated with urea show that the ammonia concentration may be as high as 93 mgm. ammonia-nitrogen per 100 grams of dry soil which is a concentration of 930 p.p.m. (table 2). From the results of laboratory studies, it appears that this concentration of ammonia is sufficient to prevent growth of T. basicola at pH 8.1. The reaction of the soil when this analysis was made was pH 8.85. Further analyses showed that toxic concentrations of ammonia prevailed for several weeks. Since root rot failed to develop on tobacco seedlings grown in soil treated with 1/2 pound or more of urea (table 4), it appears that the ammonia accumulated in the soil by the breakdown of this heavy application of urea brings about the destruction of T. basicola in the soil.

The effect of calcium cyanamid on T. basicola in the soil was not included in this study but Clayton (1) has reported that calcium cyanamid is ineffective in controlling black root rot of tobacco. The calcium residue from this material would be expected to leave the soil very alkaline and thus produce a favorable medium for root rot development; whereas, urea would have a tendency to cause the soil to be more acid and thus produce a medium unfavorable for the development of root rot.

#### DISCUSSION

The results of experiments to date indicate that heavy applications of either urea or calcium cyanamid to soil to be used for tobacco plant beds will give effective control of weeds under certain conditions. It will be necessary to determine more thoroughly the conditions that may influence the results. It is quite evident that the treatments must be made well in advance of the date of seeding the tobacco in order that injury to the seedlings may be avoided. Higher soil temperatures hasten ammonification and in all probability will give more effective results. The influence of soil organic matter and moisture has not been studied in detail, although certain tests have been made with straw added to the soil at the time of treatment. The influence of these environmental factors may make it necessary to modify the procedure for different sections. A sandy soil, low in organic matter, might not retain enough of the nitrogen to grow the tobacco plants. In this case, it would be necessary to apply, at the time of seeding the tobacco, a fertilizer carrying nitrogen as well as phosphates and potassium. On the other hand, soil containing more organic matter may retain a sufficient amount of the nitrogen from the urea and calcium cyanamid for the growth of the tobacco seedlings. In this case an additional application of a nitrogenous fertilizer might cause injury to the tobacco plants.

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Large amounts of ammonia accumulate in the soil during ammonification of urea and the pH of the soil during this period is very high. Since laboratory tests showed that ammonia salts inhibit the growth of T. basicola in alkaline media, it would appear that the accumulation of ammonia would also be toxic to the fungus in the soil. This assumption is supported by the failure of root rot to develop on tobacco seedlings grown on T. basicola-infested soil following treatment with urea.

#### LITERATURE CITED

- (1) Clayton, E. E., et al.- Soil treatments for tobacco plant beds.  
Abs. Phytopath. 31:6. 1941.
- (2) Henderson, R. G.-Methods of sterilizing plantbed soil. Abs.  
Proc. Va. Acad. Sc. 1937-1938. p. 45. 1938.

RESEARCH LABORATORIES RECEIVE A-2 PRIORITY RATING

EDITOR'S NOTE: For the information of our readers connected with laboratory research, we print the following announcement, issued by the Office of Production Management, August 30, 1941. OPM advises that it believes the priority rating announced in this statement will be sufficiently high to enable research laboratories to obtain all the materials they need to carry on scientific research. OPM says: "The proper use of this Plan will enable a laboratory to carry on its research work and will prevent interruptions and losses in efficiency which would interfere seriously with the defense program." All reports to be filed and all inquiries concerning the Plan and requests for copies of the Order and forms to be used should be addressed to the Chemical Branch, Office of Production Management, Washington, D.C.

The great importance of scientific research to the Defense Program and to the public at large was given official recognition today in an order signed by E. R. Stettinius, Jr., Director of Priorities, granting the high defense priority rating of A-2 to equipment needed by research laboratories.

The Priorities Division has secured the assistance of the National Academy of Sciences in the operation of the new Research Laboratories Supplies Plan. The Academy will advise upon applications from laboratories for assistance under the plan.

A laboratory experiencing difficulty in securing essential materials, and wishing to qualify for the A-2 rating, should apply to the Chemical Branch, Office of Production Management, Washington, D. C., on Form PD-88.

The preference rating may be extended as far as necessary to assure ultimate delivery of scarce materials to the laboratory. A laboratory, when applying for the rating, should specify the number of copies of the order which will be necessary to enable its suppliers to serve them upon their own sub-suppliers. No extensions of the rating to suppliers will be made directly by the Priorities Division. This must be done by the laboratory itself.

In the event that the laboratory finds itself unable to obtain some essential material with the A-2 rating, it should file an application with the Priorities Division on Form PD-1. If the research project is deemed of sufficient importance, the Priorities Division will issue an individual preference rating certificate, assigning a higher rating to a particular delivery of specified material.

There are in the United States some 2,000 research laboratories which use small quantities of about 5,000 chemicals and require in their operation 25,000 different instruments.